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ABSTRACT

The technical reports and working papers published by the Center for Children and Technology that are listed in this guide focus on educational technology and its relationship to student learning and school restructuring. Technical reports share research results, describe prototype designs, and address issues crucial to the Center's research agenda. Working papers are more informal reflections on the research process. The listings for 51 technical reports include title, author, publication date, a brief description of the paper, its availability, where it has been published or its ERIC document number, and the number of pages. Topics include microcomputers and their implementation in and impact on elementary and secondary schools; problem solving and Logo programming; computer software issues; cognitive processes and computer use; sex differences issues; learning environments that incorporate educational technologies; databases; programming skills; mathematics instruction; interactive video in the classroom; science instruction; conducting research in classrooms; and the design of educational computer software. The listings for four working papers include the title, author, publication date, description of the paper, and number of pages. Topics include interactive video; interactive multimedia; elementary earth science instruction; and cultures and gendered values. A further listing of 16 Center for Technology in Education technical reports includes title, author, publication date, description, availability, and number of pages for each report. Topics include computer-supported writing; educational testing; multiple intelligences; teachers' beliefs; organizational impact of school computers; school restructuring; disadvantaged students; assessing school performance; discovery-oriented programs; and interactive multimedia learning. (DB)

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CENTER FOR CHILDREN AND TECHNOLOGY

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Technical Reports & Working Papers: A Publication History

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Technical Reports & Working Papers: A Publication History

The staff of the
Center for Children and Technology

In 1981 the Center for Children and Technology began publishing technical reports and working papers. Educators and policy-makers seeking guidance, as well as researchers, designers, and students, rely on these reports to articulate new ideas and new goals for the use and design of educational technology. These papers represent a crucial contribution to current images of educational technology and its relationship to student learning and school restructuring.

Technical reports share research results, describe prototype designs, and address the issues crucial to our research agenda. Working papers are more informal reflections on the research process. Taken together, the reports characterize the development of the Center through the last decade.

Listings for reports currently available from the Center begin on page 6.

(TR-1) **ISSUES RELATED TO THE IMPLEMENTATION OF COMPUTER TECHNOLOGY IN SCHOOLS: A CROSS-SECTIONAL STUDY**
Karen Sheingold, Janet Kane, and Mari Endreweit
February 1981
No longer available as a technical report. Published as: Microcomputer use in schools: Developing a research agenda. *Harvard Educational Review*, 1983, *53* (4), 412-432.

(TR-2) **STUDY OF ISSUES RELATED TO THE IMPLEMENTATION OF COMPUTER TECHNOLOGY IN SCHOOLS**
Karen Sheingold, Janet Kane, Mari Endreweit, and Karen Billings
July 1981, 137 pages
No longer available as a technical report. ERIC ED319370

(TR-3) **MICROCOMPUTERS IN SCHOOLS: IMPACT ON THE SOCIAL LIFE OF ELEMENTARY CLASSROOMS**
Jan Hawkins, Karen Sheingold, Meryl Gearhart, and Chana Berger
1982
No longer available as a technical report. Published in *Journal of Applied Developmental Psychology*, 1982, *3*, 361-373.

(TR-4) **WHAT IS PLANNING DEVELOPMENT THE DEVELOPMENT OF?**
Roy D. Pea
Spring 1982
No longer available as a technical report. Published in D. Forbes & M.T. Greenberg (Eds.), *New directions for child development: children's planning strategies* (pp. 527). San Francisco: Jossey-Bass, 1982.

(TR-5) **LOGO RESEARCH AT BANK STREET COLLEGE**
Jan Jewson (Hawkins) and Roy D. Pea
Spring 1982
No longer available as a technical report. Published in *Byte*, August 1982, 332-333.

(TR-6) **THE FLEXIBLE USE OF COMPUTERS IN CLASSROOMS**
Jan Hawkins
November 1982, 8 pages
No longer available as a technical report. ERIC ED249926

(TR-7) **PROSPECTS AND CHALLENGES FOR USING MICROCOMPUTERS IN SCHOOLS**
Roy D. Pea
February 1984, 20 pages
No longer available as a technical report.
ERIC ED249927
This paper, prepared as an address for educator groups, provides a theoretical perspective for thinking about problems and prospects for integrating microcomputer uses in school activities. Six major aspects of the perspective are defined: (1) the computer as general-purpose symbolic device; (2) the importance of developmental studies of children's understanding; (3) the importance of teachers and instruction; (4) the need to make computer-based learning purposive; (5) the aim of meeting educational goals effectively; and (6) the guidance of computer use by educational values. Current innovative uses of school computer technologies are discussed in terms of this perspective.

(TR-8) **EDUCATIONAL SOFTWARE TOOLS: DESIGNING A TEXT EDITOR FOR CHILDREN**
D. Midian Kurland
January 1983, 9 pages
No longer available as a technical report.
ERIC ED249928

(TR-9) **ON THE COGNITIVE EFFECTS OF LEARNING COMPUTER PROGRAMMING**
Roy D. Pea and D. Midian Kurland
October 1983, 45 pages
No longer available as a technical report.
Published in *New Ideas in Psychology*, 1984, *2* (3), 137-168.
ERIC ED249919

(TR-10) **CHILDREN'S MENTAL MODELS OF RECURSIVE LOGO PROGRAMS**
D. Midian Kurland and Roy D. Pea
February 1983, 9 pages
No longer available as a technical report.
Published in *Journal of Educational Computing Research*, 1985, 1(2), 235-243.
ERIC ED249929

(TR-11) **CHILDREN'S PLANNING PROCESSES IN A CHORE-SCHEDULING TASK**
Roy D. Pea and Jan Hawkins
March 1984, 34 pages
No longer available as a technical report.
Published in S. L. Friedman, E. K. Scholnick, & R. R. Cocking (Eds.), *Blueprints for thinking: The development of social and cognitive planning skills*. New York: Cambridge University Press, 1984.
ERIC ED249920

(TR-12) **LOGO PROGRAMMING AND PROBLEM SOLVING**
Roy D. Pea
April 1983, 9 pages
No longer available as a technical report.
ERIC ED319371

(TR-14) **RESEARCH AND DESIGN ISSUES CONCERNING THE DEVELOPMENT OF EDUCATIONAL SOFTWARE FOR CHILDREN**
Cynthia A. Char
April 1983, 5 pages
No longer available as a technical report.
ERIC ED319374

(TR-15) **SOFTWARE IN THE CLASSROOM: ISSUES IN THE DESIGN OF EFFECTIVE SOFTWARE TOOLS**
D. Midian Kurland
April 1983, 10 pages
No longer available as a technical report.
ERIC ED 319372

(TR-16) **LOGO PROGRAMMING AND THE DEVELOPMENT OF PLANNING SKILLS**
Roy D. Pea and D. Midian Kurland
March 1984, 55 pages
ERIC ED249930
Findings are presented from two separate year-long longitudinal studies of the de-

velopment of planning skills among school-aged children in relation to learning Logo programming, and a theoretical context is provided for predictions of greater improvement by the programming groups. In the first year, experimental and control groups were administered a classroom chore-scheduling planning task; process and product measures of planning skill revealed no benefits for students doing Logo programming. In the second year, a microcomputer version of this task was implemented in which students gave commands to a robot to carry out the chores, and similar assessments of planning performances were collected on-line. Again, learning to program did not differentiate experimental from control group performances. Further tests of the programming transfer hypothesis are proposed.

(TR-18) **ON THE COGNITIVE PREREQUISITES OF LEARNING COMPUTER PROGRAMMING**
Roy D. Pea and D. Midian Kurland
June 1983, 91 pages
No longer available as a technical report.
ERIC ED249931

(TR-l9) **STRUCTURED INTERVIEWS ON CHILDREN'S CONCEPTIONS OF COMPUTERS**
Ronald Mawby, Catherine A. Clement, Roy D. Pea, and Jan Hawkins
February 1984, 38 pages
ERIC-ED249932]
This paper discusses in-depth structured interviews with 8- to 9-year-old and 11- to 12-year-old students conducted before and after a year-long discovery-learning exposure to Logo in the classroom. The interviews explored children's conceptions of what computers are used for, the parts of the computer and how they work, the computer's role in problem solving, what people must know to use computers, and the relation between computer operations and human thinking processes.

(TR-22) **CHAMELEON IN THE CLASSROOM: DEVELOPING ROLES FOR COMPUTERS**
April 1983, 62 pages
No longer available as a technical report.
ERIC ED249921

(TR-23) **CLASSROOM SOFTWARE FOR THE INFORMATION AGE**
Karen Sheingold, Jan Hawkins, and D. Midian Kurland
November 1983, 9 pages
No longer available as a technical report.
ERIC ED249933

(TR-24) **COMPUTERS AND GIRLS: RETHINKING THE ISSUES**
Jan Hawkins
April 1984, 19 pages
No longer available as a technical report.
Published in *Journal of Sex Roles*, 1985, *13*, 165-180.
ERIC ED249922

(TR-25) **FUNCTIONAL ENVIRONMENTS FOR MICROCOMPUTERS IN EDUCATION**
Denis Newman
May 1984, 12 pages
No longer available as a technical report.
Published in R. D. Pea & K. Sheingold (Eds.), *Mirrors of minds: Patterns of experience in educational computing*. Norwood, NJ: Ablex, 1987.
ERIC ED253195

(TR-26) **THE MICROCOMPUTER AS A MEDIUM FOR YOUNG CHILDREN**
Karen Sheingold
May 1984, 13 pages
No longer available as a technical report.
Published as: The microcomputer as a symbolic medium. In P. F. Campbell & G. G. Fein (Eds.), *Microcomputers in early education: Conceptualizing the issues*. Reston, VA: Reston Publishing, 1986.
ERIC ED249923

TR-27) **"I'M THE THINKIST, YOU'RE THE TYPIST": THE INTERACTION OF TECHNOLOGY AND THE SOCIAL LIFE OF CLASSROOMS**
Karen Sheingold, Jan Hawkins, and Cynthia Char
June 1984, 14 pages
No longer available as a technical report. Published in *Journal of Social Issues*, 1984, 40(3), 49-62.
ERIC ED249924

(TR-28) **INFORMATION MANAGEMENT TOOLS FOR CLASSROOMS: EXPLORING DATABASE MANAGEMENT SYSTEMS**
Carla Freeman, Jan Hawkins, and Cynthia Char
July 1984, 30 pages
ERIC ED249925
Using the computer as a tool for information handling presents rich educational possibilities. This paper discusses our investigation of eight elementary and junior high schools using database management systems (DBMS) with students in several curricular areas. The application of this kind of tool software leads to interesting insights about the ways in which children learn to make sense of and use information. Two case studies are included to provide a vivid account of (1) the school settings for such computer use; (2) teachers' goals for database activities; (3) the specific activities they engaged the children in; (4) the difficulties they had in using the software; and (S) some overall interpretations concerning the effectiveness of DBMs as educational tools.

(TR-29) **DEVELOPMENTAL STUDIES OF COMPUTER PROGRAMMING SKILLS**
Edited by D. Midian Kurland
October 1984, 131 pages
ERIC ED257441
This is a collection of papers presented at the 1984 AERA Symposium entitled "Developmental Studies of Computer Programming." The report includes five research papers: *Mapping the cognitive demands of learning to program* by Kurland, Clement, Manby, & Pea; *The development of programming expertise in adults and children* by Kurland, Mawby, & Cahir; *Issues and problems in studying transfer effects of programming* by Ehrlich, Abbott, Salter, Soloway; *What will it take to learn thinking skills through computer programming* by Pea; and *Making programming instruction cognitively demanding: An intervention study* by Dalby, Tournaire, Linn; as well as an introduction by D. Midian Kurland and a discussion by Jan Hawkins.

(TR-30) **TOWARD COGNITIVE TECHNOLOGIES FOR WRITING**
Roy D. Pea and D. Midian Kurland
December 1984, 47 pages
[To appear in Review of Research in Education, 13.]
ERIC ED258560
Writers of diverse skill levels are writing with computers, and many children have begun to write with a keyboard before touching pencil and paper. Clearly, the practice of writing in schools and everyday work settings is changing in fundamental ways. This paper is a synthesis of some of the ideas and issues pertaining to research on the development of writing skills and on creating new technologies for writing. The paper draws attention to the fundamental issues that both researchers and software designers must address if the next generation of writing tools is to be qualitatively better than what is available today.

(TR-31) **LANGUAGE-INDEPENDENT CONCEPTUAL "BUGS" IN NOVICE PROGRAMMING**
Roy D. Pea
December 1984, 12 pages
ERIC ED319373
This paper argues for the existence of persistent conceptual "bugs" in how novices program and understand programs. These bugs are not specific to a given pro-

gramming language, but appear to be language-independent. Furthermore, such bugs occur for novices from primary school to college age. Three different classes of bugs--parallelism, intentionality, and egocentrism--are identified, and exemplified through student errors. It is suggested that these classes of conceptual bugs are rooted in a "superbug," the default strategy that there is a hidden mind somewhere in the programming language that has intelligent interpretive powers.

(TR-32) **INTEGRATING HUMAN AND COMPUTER INTELLIGENCE**
Roy D. Pea
December 1984, 25 pages
No longer available as a technical report. Published in E. Klein (Ed.), *Children and computers: New directions for child development* (No. 28). San Francisco: Jossey-Bass, 1985.
ERIC ED257449

(TR-33) **PAIRED PROBLEM SOLVING IN A COMPUTER CONTEXT**
Jan Hawkins, Moni Homolsky, and Peggy Heide
December 1984, 8 pages
ERIC ED258551
Collaborative work arrangements are common features of people's lives. In this paper, the general nature of collaborative work in classrooms is discussed. This framework is applied to the interpretation of a study which examined how pairs of children worked together to solve computer programming problems in the Logo language. The children's collaborative work when they were first learning Logo was compared with their work on a similar though more difficult set of problems after a year's experience with Logo.

(TR-34) **THE INTERPRETATION OF LOGO IN PRACTICE**
Jan Hawkins
March 1985, 35 pages
No longer available as a technical report. Published in R. D. Pea & K. Sheingold (Eds.), *Mirrors of minds: Patterns of experience in educational computing.* Norwood, NJ: Ablex, 1987.
ERIC ED257452

(TR-35) **THE BEGINNING OF A STORY: COMPUTERS AND THE ORGANIZATION OF LEARNING IN CLASSROOMS**
Jan Hawkins and Karen Sheingold
May 1985, 21 pages
No longer available as a technical report. Published in J. Culbertson L L. L. Cunningham (Eds.), *Microcomputers in education* (pp. 40-58). Chicago: University of Chicago Press, 1986.

(TR-36) **PREPARING URBAN TEACHERS FOR THE TECHNOLOGICAL FUTURE**
Karen Sheingold, Laura M. W. Martin, and Mari Endreweit
October 1985, 26 pages
No longer available as a technical report. Published in R. D. Pea & K. Sheingold (Eds.), *Mirrors of minds: Patterns of experience in educational computing.* Norwood, NJ: Ablex, 1987.

(TR-37) **COGNITIVE TECHNOLOGIES FOR MATHEMATICS EDUCATION**
Roy D. Pea
March 1986, 37 pages
ERIC ED295791
This paper develops, first, an historical perspective on roles for cognitive technologies in thinking as reorganizers rather than amplifiers of mind. It is in this context, it is suggested, that we can best understand the transformational roles of advanced technologies for mathematical thinking and education, and thereby contribute productively to research and practice on computers in mathematics education. Computers are doing far more than making it easier to do what we are doing. It is in terms of this historical context that the drastic reformulations of aims and methods of mathematics education computers have wrought makes sense. A heuristic taxonomy of seven functions that mathematics

educational technologies can serve to promote the aims of mathematical thinking is then proposed. Two types of functions are distinguished: *purpose* functions that may affect whether students choose to think mathematically; and *process* functions that may support the component mental activities of mathematical thinking. It is hoped that the functions distinguished with these two categories express transcendent features of cognitive technologies helpful for students learning to think mathematically, and that they can be used retroactively to assess existing software, and proactively to guide software development efforts.

(TR-38) **BEYOND AMPLIFICATION: USING THE COMPUTER TO REORGANIZE MENTAL FUNCTIONING**
Roy D. Pea
March 1986, 32 pages
No longer available as a technical report.
Published in *Educational Psychologist*, 1985, 20,
ERIC ED297706

(TR-39) **DESIGN OPTIONS FOR INTERACTIVE VIDEODISC: A REVIEW AND ANALYSIS**
Cynthia A. Char and Denis Newman
April 1986, 18 pages
ERIC ED297707
More than 30 interactive videodiscs are reviewed to illustrate ways in which designers can make use of the unique potential of the medium for children's education. Analyses of discs that are controlled directly by the videodisc player (level 1) and discs that are controlled by an external computer (level 3) indicate a wide range of options which are often underutilized. Making the most of the medium involves a mixture of motion video, still frames, and text with each format being used to support the others.

(TR-40) **TEACHERS' ADOPTION OF MULTIMEDIA TECHNOLOGIES FOR SCIENCE AND MATHEMATICS INSTRUCTION**
Laura M. W. Martin
June 1986, 25 pages
No longer available as a technical report.
Published in R. D. Pea & K. Sheingold (Eds.), *Mirrors of minds: Patterns of experience in educational computing*. Norwood, NJ: Ablex, 1987.
ERIC ED297708

(TR-41) **GETTING THE PICTURE: FOUR CLASSROOM CASE STUDIES OF VIDEODISC USE IN SCHOOLS**
Cynthia Char and William Tally
November 1986, 36 pages
ERIC ED297709
This paper presents findings from an intensive classroom-based study investigating the potential promise and challenge in integrating videodisc technology into schools. The research involved four elementary and middle-school teachers during the early implementation phases of incorporating archival videodiscs into their art and science classrooms. We discuss, among other things, multiple models of videodisc use, the potential of videodiscs for teaching and learning as an alternative to more traditional media, and the role of teachers in incorporating videodisc technology into schools. Also discussed are the implications of the research for videodisc design and development.

(TR-42) **CHILDREN'S USE OF THE UNIQUE FEATURES OF INTERACTIVE VIDEODISCS**
William Tally and Cynthia Char
January 1987, 19 pages
ERIC ED319375
An exploratory study was conducted of children's interactions with a level 1 (noncomputer controlled) videodisc system, focusing on their use of the medium's novel features (two independent sound tracks, freeze frame capability, variable play speed, variable direction of play, and frame-accurate search-

ing). Researchers observed pairs of 9- and 10-year-old children interacting with two videodiscs designed for home entertainment that encouraged use of these features. Outcomes indicated that elementary-aged children are well able to exploit the flexibility and control offered by the medium in order to learn and have fun. Results are discussed in terms of the children's ability to initially grasp the nature of the videodisc features, to use them in relation to particular game and learning goals, and to invent games that are not explicitly part of the disc design.

(TR-43) **LOCAL AND LONG DISTANCE COMPUTER NETWORKING FOR SCIENCE CLASSROOMS**
Denis Newman
February 1987, 9 pages
ERIC ED319376
This paper reports formative and design research for the Earth Lab project, which integrates local and long-distance computer-mediated communication for elementary science. A communication system is developed which, because it is based on the same word processing system, simplifies access to communications. Local communication activities are developed which require more temporal coordination than is possible in long-distance contexts.

(TR-44) **THE PALENQUE OPTICAL DISC PROTOTYPE: DESIGN OF MULTIMEDIA EXPERIENCES FOR EDUCATION AND ENTERTAINMENT IN A NONTRADITIONAL LEARNING CONTEXT**
Kathleen S. Wilson
May 1987, 15 pages
ERIC ED319377
Palenque is an interactive, multimedia, optical disc research prototype which has been developed for home use by 8- to 12-year-old children and their families. It varies in several ways from interactive videodiscs with more traditional instructional design principles. Since the project is a research and development effort rather than a product development effort, we have been able to experiment with the nature of the design as well as with the design process itself. In this experimental vein, we have attempted to incorporate many interactive learning formats into the Palenque disc. At the core, Palenque is a database that includes information stored in a variety of formats (graphics, text, slides, narration, motion video, sounds), which has been organized to foster browsing rather than key word searching. Palenque also has elements of simulations, virtual travel, museum exhibits, interactive games and books, and linear television narratives, all accessible via an intuitively simple interface. The unique demands of our goals, target audience, learning philosophy, choice of medium, and formative research tradition have all influenced the nature of our design and development decisions.

(TR-45) **TEACHING TECHNOLOGY: CREATING ENVIRONMENTS FOR CHANGE**
Margaret A. Honey, Laura M. W. Martin, and Shari Robinson
October 1987, 10 pages
ERIC ED319378
This paper presents some of the lessons that media designers and researchers learned from observing teachers using the first season *The Voyage of the Mimi* materials, a multimedia science and mathematics program for children. The application of that information to the design of learning modules accompanying *The Second Voyage of the Mimi* is described, particularly the design of the Maya Math software module, which attempts to incorporate an explicit structure to facilitate the practice of discovery-based learning. A field test study of the module is discussed.

(TR-46) **MICROWORLDS TO MACROWORLDS: CONCEPTUAL TRANSFER AND ACTIVITY SETTING**
Laura M. W. Martin, Maxine Shirley, and Mary McGinnis
December 1987, 11 pages
ERIC ED319379

The study discussed in this paper examined the transfer of children's learning from a microworld environment to other settings, in particular, the learning and transfer of concepts and representations and how a microworld environment affects instructional interactions. Fifteen fifth- and sixth-grade children used an ecology simulation game, *Island Survivors*, while their classmates used other science software. Three domains for possible transfer of software ecology concepts were examined: answering an individual set of paper-and-pencil picture tasks; constructing a vivarium in a small group; and notating information during a walk in the park. The results showed that children applied concepts from the microworld individually when the materials resembled the microworld graphically, and in groups when the interindividual setting was similar to that of the microworld. There was some evidence that a teacher-taught concept was applied by groups as a result of the microworld experience; the park walk showed no effects of the microworld experience. We feel that the results demonstrate that children's awareness of certain science concepts can be enhanced through a relatively brief experience manipulating a microworld environment, which occurs in large measure because of the impact of the experience on children's interactions around the microworld content.

(TR-47) **THE PALENQUE PROJECT: A PROCESS OF DESIGN AND DEVELOPMENT AS RESEARCH IN THE EVOLUTION OF AN OPTICAL DISC PROTOTYPE FOR CHILDREN**
Kathleen S. Wilson and William J. Tally
December 1987, 12 pages
To appear in B. N. Flagg, *Improving electronic learning materials through formative evaluation*. Hillsdale, NJ: Erlbaum.
ERIC ED319391

This paper describes the development of Palenque, an optical disc prototype, developed collaboratively by Bank Street College of Education and the David Sarnoff Research Center to be a rich, multimedia database environment for children's learning and enjoyment. The design and development process is characterized as an enterprise of open-ended research, simultaneously involving technical experimentation, formative testing of the interface conventions with child users, and inquiry aimed at discovering what kinds of multimedia environments might promote active and self-guided exploration, information seeking, and decision making on the part of children. The paper includes a description of the Palenque prototype and its major components and unique features, a profile of the design and development team, a description of the target audience and the context for use, and a discussion of the concurrent and iterative processes of design, research, and production as they shaped the prototype's evolution over a two-year period.

(TR-48) **CHALLENGES OF FORMATIVE TESTING: CONDUCTING SITUATED RESEARCH IN CLASSROOMS**
Jan Hawkins & Margaret Honey
February 1990, 5 pages
ERIC ED319380

This paper stresses the importance of situated research to our understanding of how interactive technologies function within the complex social environment of a classroom. Although small-group experiments can bring to light specific strengths and weaknesses of a piece of software, situated classroom research is crucial to the development of a final product which can be successfully integrated into teaching and learning. Teacher interpretation of the software,and its relation to the ongoing content curriculum, organizational structure and social environment of the classroom are all questions best addressed by situated research. Through discussions of *Inquire* and *Voyage of the Mimi* prototypes, it is concluded that situated re-

search can have critical impact on the final shape of the product and on the design and development of accompanying materials, as well as documenting those factors that contribute to successful technology integration.

(TR-49) **THE ROLE OF FORMATIVE RESEARCH IN THE DESIGN OF EDUCATIONAL COMPUTER SOFTWARE**
Margaret Honey
February 1990, 7 pages
ERIC ED319392
Three main characteristics of educational software are evaluated during formative research: comprehensibility, appeal, and usefulness. However, the assessment of these functions is always complicated by the circumstances of the study; conclusions drawn from small-scale, time-restricted research must inevitably be contextualized and interpreted by a knowledgeable researcher. Through a case study -- the development of the Maya Math software component of *The Second Voyage of the Mimi* -- this paper explores the complex skills required to perform this highly intuitive research, and the role of the researcher as both a translator for designers and an advocate for students.

(TR-50) **DESIGNING INQUIRE**
Cornelia Brunner
February 1990, 14 pages
ERIC ED319393
This paper provides an overview of the structure of *Inquire*, a software tool designed to support children's systematic investigations. Originally written for MS-DOS machines, a Macintosh version, written in Hypertalk, is currently being used for research purposes. *Inquire* provides structural, procedural support, rather than tutoring or coaching, through a series of tools and cards that encourage students to take notes in organized and useful ways, make connections between old and new information, look at information from more than one perspective, and develop meaningful questioning strategies. After a general overview of the purpose and design of *Inquire*, this paper discusses and illustrates each of the major features of the program.

(TR-51) **LITERACY AND THE SCIENCE CLASSROOM**
"Words and Science:" Jan Hawkins & Laura Martin
"Taking Notes and Taking Note of Physics;" Babette Moeller, Jan Hawkins, Cornelia Brunner, & Sol Magzamen
"Computer Networking and the Connection of Science and Literacy Skills:" Shelly V. Goldman & Carol Reich
March 1990, 20 pages
This collection of papers was presented at a symposium of the same name at the American Educational Research Association meetings in San Francisco, in March, 1989. A fourth paper from that symposium, *Discourses on the Seasons*, by Sarah Michaels and Bertram Bruce, is available as a technical report from the Educational Development Center.

The aim of these papers is to explore aspects of language use in science classrooms descriptively and prescriptively, based on naturalistic and experimental observations. Each of the authors has been involved in creating computer-based activities for facilitating scientific inquiry in elementary or middle school classrooms. Each paper points to the verbal mode of organizing information as a central issue in the projects. In addition to this common issue, each project's unique methods and approaches to the topic of language and scientific understanding are discussed.

Working Papers

(WP-1) **"THE VOYAGE OF THE MIMI" INTERACTIVE VIDEO PROTOTYPE: DEVELOPMENT OF AN EXPLORATORY LEARNING ENVIRONMENT FOR CHILDREN**
Kathleen S. Wilson

February 1987, 8 pages

While industrial and military training applications for interactive videodiscs are expanding rapidly, the use of the medium in children's learning is far less developed. In an effort to study more carefully the potential for interactive video in children's education, we have designed, produced, and researched an experimental videodisc. This research videodisc draws on themes and footage from *The Voyage of the Mimi*, a television series for elementary and middle school children produced by Bank Street College, which provides schools with a multimedia format for science education. Rather than tutorial in nature, our videodisc prototype attempts to motivate and foster learning through self-guided exploration and information gathering. Small-scale formative research with children has helped to shape our ongoing design decisions.

(WP-2) **PALENQUE: AN INTERACTIVE MULTIMEDIA OPTICAL DISC PROTOTYPE FOR CHILDREN**

Kathleen S. Wilson

March 1987, 8 pages

The Palenque interactive multimedia optical disc prototype is based on themes, locations, and characters from The *Second Voyage of the Mimi* television show, which is being produced at Bank Street College. In the TV show, a cast of scientists and children explore the Yucatan's ancient Maya ruins and are introduced to the science of archeology. Our Palenque prototype has incorporated this theme to the extent that the user's experience is based on a virtual travel exploration of the ancient Maya Museum site, Palenque, and on the perusal of a multimedia Palenque Museum database. One of our goals was to create a visually interesting database environment in which information in many formats could be browsed through spatially and thematically by children. In addition, we have experimented with icon and window-based interface conventions that might make navigation around the optical disc environment motivating and comprehensible for young users.

(WP-3) **COLLABORATIVE NETWORK ACTIVITIES FOR ELEMENTARY EARTH SCIENCE**

Deborah Brienne and Shelley Goldman

September 1988, 8 pages

The Earth Lab Project researched ways that local area computer networks could be used to support real-world, collaborative scientific research in elementary schools. This paper describes earth science curriculum activities designed for the network, which include the use of databases and electronic mail, and points out how these are supportive of quality science investigations.

(WP-4) **TECHNOLOGICAL CULTURES AND GENDERED VALUES: EXPLORING RELATIONSHIPS OF CONFLICT AND COMPROMISE**

Margaret Honey

July 1990, 4 pages

This paper presents one researcher's reflections on the findings of one portion of the Women and Technology study. This phase of the project examined the language used by women in technology-oriented careers when they discuss their feelings about their work. Technical reports describing the entire study in detail are forthcoming.

CENTER FOR TECHNOLOGY IN EDUCATION

This five-year project funded by U.S. Department of Education, Office of Educational Research and Improvement, is driven by a research agenda that has several interrelated parts. The project is a collaborative effort of CCT, Harvard University, Brown University, and Bolt, Beranek & Newman Laboratories. Papers discussing the CTE research agenda are listed below.

(TR1) **TOWARD A DESIGN SCIENCE OF EDUCATION**
Allan Collins
February 1990, 6 pages

Many technologies have been introduced in classrooms all over the world, but these innovations have provided remarkably little systematic knowledge or accumulated wisdom to guide the development of future innovations. This paper introduces the program of work being undertaken by the Center for Technology in Education, which consists of three components: to synthesize research on technological innovations; to develop a methodology for carrying out *design experiments*; to study different ways of using technology in classrooms and schools; and to begin to construct a systematic science of how to design educational environments so that new technologies can be introduced successfully.

(TR2) **A SYSTEMS APPROACH TO EDUCATIONAL TESTING**
John R. Frederiksen & Allan Collins
December 1989, 9 pages
ERIC TM015668

This paper is concerned with the validity of educational tests when they are employed as critical measures of educational outcomes within a dynamic system. The problem of validity arises if an educational system adapts itself to the characteristics of the outcome measures. The concept of systemically valid tests is introduced; these are tests that induce curricular and instructional changes in education systems (and learning strategy changes in students) that foster the development of the cognitive traits that the tests are designed to measure. General characteristics are analyzed that contribute to or detract from a testing system's systemic validity, such as the use of direct rather than indirect assessment. These characteristics are then applied to the development of a set of design principles for creating testing systems that are systemically valid. Finally, the proposed principles are illustrated, by applying them to the design of a student assessment system. This design example addresses not only specifications for the tests, but also the means of teaching the process of assessment to users of the system.

This paper was published in the December, 1989 issue of *Educational Researcher*, Vol. 18, No. 9, pp. 27-32.

(TR3) **ALTERNATE REALIZATIONS OF PURPOSE IN COMPUTER-SUPPORTED WRITING**
Andee Rubin & Bertram Bruce
February 1990, 9 pages

This paper challenges the notion that technology can, by itself, effect change in a classroom. Through an examination of various classrooms using QUILL, a system of tools and environments to support classroom writing, the gap between the intended purpose of a technological innovation and its eventual role in the classroom is shown to be wide and unpredictable. Innovations not anticipated by the designers result when a new tool is introduced into the social setting of a classroom, because the tool must be integrated with the habits, beliefs, and practices of the classroom. The authors conclude that these various realizations of purpose are an important part of the process of educational innovation and technological integration.

(TR4) **MULTIPLE INTELLIGENCES GO TO SCHOOL: EDUCATIONAL IMPLICATIONS OF THE THEORY OF MULTIPLE INTELLIGENCES**
Howard Gardner & Thomas Hatch
November 1989, 9 pages
ERIC TM015638
A new approach to the conceptualization and assessment of human intelligences is described. According to Gardner's Theory of Multiple Intelligences, each human being is capable of seven relatively independent forms of information processing, with individuals differing from one another in the specific profile of intelligences that they exhibit. The range of human intelligences is best assessed through contextually based, "intelligence-fair" instruments. Three research projects growing out of the theory are described. Preliminary data secured from Project Spectrum, an application in early childhood, indicate that even 4- and 5-year-old children exhibit distinctive profiles of strength and weakness. Moreover, measures of the various intelligences are largely independent and tap abilities other than those measured by standard intelligence tests.

This paper was published in the November 1989 issue of *Educational Researcher*, Vol. 18, No. 8, pp. 4-10.

(TR5) **DOMAIN PROJECTS AS ASSESSMENT VEHICLES IN A COMPUTER-RICH ENVIRONMENT**
Joe Walters & Howard Gardner
June 1990, 12 pages
ERIC TM015639
This paper provides an overview of assessment research recently conducted at Project Zero at the Harvard Graduate School of Education. The authors summarize the theory of multiple intelligences, which provides the conceptual underpinnings for their understanding of assessment, and then review different types of domain projects currently being developed. The assessment techniques discussed document student growth and learning over time and across a wide range of skills, and encourage students' self-assessment. Views of assessment described in this paper are also discussed in Frederiksen & Collins, *A Systems Approach to Educational Testing*.

(TR6) **TEACHERS' BELIEFS AND TECHNOLOGY INTEGRATION: DIFFERENT VALUES, DIFFERENT UNDERSTANDINGS**
Margaret Honey & Babette Moeller
August 1990, 13 pages
The goal of this study was to explore teachers' thinking on how and why they use or do not use information technologies in their classrooms. Are there discernible patterns in how teachers talk about their classroom practices and educational objectives that appear to either facilitate or detract from the integration of technology into their curricula? What, in turn, can we cull from this information that will enable teachers, schools, and districts to integrate technology into educational environments in deep and meaningful ways? The findings of this study suggest that for the teachers we interviewed there is a relationship between their educational goals and objectives and the ways in which they are able to integrate computer-based technologies into their ongoing classroom practices.

(TR7) **OPPORTUNITIES FOR RESEARCH ON THE ORGANIZATIONAL IMPACT OF SCHOOL COMPUTERS**
Denis Newman
September, 1990, 8 pages
As computers are acquired in greater numbers in schools, their impact on the social organization of instruction increasingly becomes an issue for research. Developments in the cognitive science of instruction, drawing on the sociohistorical theory, provide researchers with an appropriate theoretical approach to cultural tools and cognitive change, while developments in the technology of

computer-supported cooperative work provide researchers with models for organizational impact outside of education. The concept of a formative experiment in which schools are supported in the appropriation of new technology is illustrated by a project that implements local area network technology in an elementary school. The concept of appropriation derived from sociohistorical theory highlights how schools can make use of technology for goals not anticipated by the researcher.

This paper was published in April 1990 in *Educational Researcher, 19*(3), 8-13.

(TR8) **TECHNOLOGY'S ROLE IN RESTRUCTURING FOR COLLABORATIVE LEARNING**
Denis Newman
November 1990, 11 pages
The problem of supporting collaborative learning is placed in the framework of the organizational restructuring of schools. The paper contrasts the organizational impact of two technology systems in terms of: 1) the physical location in the school, 2) the curriculum and 3) how time is scheduled. Considered first is a class of computer systems for which the function is individualization. In contrast, an environment called Earth Lab is described. Examples of its use in one school illustrate the way that collaborative learning is supported in the three categories: location, curriculum and time. In conclusion, the complex relationship between school restructuring and the implementation of technology for schools is addressed.

TR9 **RESTRUCTURING FOR LEARNING WITH TECHNOLOGY**
Restructuring for Learning with Technology: the Potential for Synergy
Karen Sheingold, CTE
The Role of Computer Technology in Restructuring Schools
Allan Collins, Bolt Beranek and Newman, Inc.
Imaging Technology's Role in Restructuring for Learning
Chris Dede, University of Houston at Clear Lake
Restructuring and Technology: Partners in Change
Jane L. David, Bay Area Research Group
How Structural Change Can Speed the Introduction of Technology
Ted Kolderie, Center for Policy Studies
This collection of papers is a joint effort of the Center for Technology in Education and the National Center on Education and the Economy in Rochester, New York. They are the result of a conference held in January, 1990, at which these authors and others from relevant communities (researchers, practitioners, policymakers and technology experts) met and explored the productive intersections of their areas of expertise. Each paper addresses three major developments in education: advances in our understanding of student learning and the design of environments conducive to student engagement; the potential of current and future technological innovations to support student learning and thinking; and restructuring and reform efforts that focus on higher-order thinking and learning for all students. In each paper, the author considers how these issues can be brought together, both conceptually and in practice.

(TR10) **A COGNITIVE APPRENTICESHIP FOR DISADVANTAGED STUDENTS**
Allan Collins, Jan Hawkins, and Sharon M. Carver
March 1991, 14 pages
The authors propose that the changing nature of work in society provides a potential meeting ground where education for the advantaged and disadvantaged can come together in a curriculum where educational tasks reflect the future nature of work in society. Work is becoming computer based and requires more ability to learn and think. Hence, a curriculum built around tasks that require learning and thinking in a computer-based environment is a curriculum that

will make sense to both advantaged and disadvantaged students and will education them in ways that make sense for society at large.

(TR11) **A WORLD IN THE CLASSROOM: MAKING SENSE OF SEASONAL CHANGE THROUGH TALK AND TECHNOLOGY**
Denis Newman
February 1991, 17 pages
This paper examines science teaching in classrooms that participated with us in an experiment on ways of integrating technology into a sixth-grade science curriculum on the earth's seasons. The experiment was motivated by our observation of an almost systematic dissociation of data and theory in elementary science lessons. Researchers and teachers designed a curriculum unit that included modeling and data collection components, and integrated the use of technology into these activities.

(TR12) **THREE DIFFERENT VIEWS OF STUDENTS: THE ROLE OF TECHNOLOGY IN ASSESSING STUDENT PERFORMANCE**
Allan Collins, Jan Hawkins, & John R. Frederiksen
April 1991, 8 pages
The authors argue that if assessment heavily influences teaching and learning in schools, then testing methods used must support the development of thoughtful and critically-minded citizens. Since the view of students provided by paper-and-pencil testing is limited, Collins, et al. propose that video- and computer-based forms of assessment can be used in combination with certain kinds of paper-and-pencil testing to offer the necessary multi-faceted and richer view of students' accomplishments. Potential uses of these three media, and methods by which alternative assessment practices encourage learning, are discussed.

(TR13) **LOOKING AT MULTIMEDIA: DESIGN ISSUES IN SEVERAL DISCOVERY-ORIENTED PROGRAMS**
Kathleen Wilson & William Tally
April 1991, 11 pages
This paper presents a framework for reflecting on the design of discovery-based multimedia programs, based on a review of several multimedia design examples. Children, teachers and CTE staff reviewed the programs, using and discussing them as consumers as well as design critics. This paper provides a synthesis of their different perspectives on the programs' characteristic features, and reviews the basic components of most discovery-oriented multimedia programs.

(TR14) **TECHNOLOGY AS SUPPORT FOR SCHOOL STRUCTURE AND SCHOOL RESTRUCTURING**
Denis Newman
June 1991, 9 pages
Technology can play a role in restructuring schools, but they can also effectively support existing school structures depending on how they are design and used. This paper contrasts the organizational impact of two technology systems in terms of the physical location in the school, the curriculum and how time is scheduled. Considered first is a class of computer systems designed to fit in well with existing school organizations. In contrast, an environment called Earth Lab is described and its application in the restructuring of a school is illustrated. In conclusion, the complex relationship between school restructuring and the implementation of technology for schools is addressed.

(TR15) **DESIGNING FOR DISCOVERY: INTERACTIVE LEARNING ENVIRONMENTS AT BANK STREET COLLEGE**
Kathleen Wilson & Bill Tally
June 1991

This series of interviews is an effort to discuss a broadly-defined word – "multimedia" – through a narrow focus – as it applies to successful learning environments at Bank Street College, ranging from pre-electronic to electronic. A Bank Street professor, researcher, and two Bank Street School for Children teachers each offers a different perspective for thinking about the character and quality of the learning situation, the nature of learning materials, the structure of the learning environment, the kinds of interactions that are built into those environments, and the theory of learning and child development implicit in their work. Other Bank Street staff respond to the need for a variety of design models for electronic multimedia environments. Two models are discussed: The Voyage of the Mimi and Palenque.

(TR16) **CLASSROOM INTEGRATION OF INTERACTIVE MULTIMEDIA: A CASE STUDY**
Kathleen Wilson & Bill Tally
June 1991

New interactive multimedia tools and applications are becoming available for use in classrooms, but little is known about the nature and value of using such materials nor the conditions which might best support their integration into classrooms. This paper describes a brief exploratory look at what can happen when multimedia hardware and software are introduced into a supportive school and classroom setting. Within a few weeks of their introduction into a fifth-grade classroom, multimedia materials had become part of the classroom culture, and were being used by students for game-playing, research, and, most interestingly, the creation of individual and collaborative presentations and interactive multimedia "reports." This paper describes the highlights of children's work as multimedia "authors," and details the conditions which surrounded and supported their work.

Special Report: **ACCOMPLISHED TEACHERS: INTEGRATING COMPUTERS INTO CLASSROOM PRACTICE**
Karen Sheingold & Martha Hadley
September 1990, 32 pages

The Center for Technology in Education conducted a nationwide survey of teachers who are experienced and accomplished at integrating computers into their teaching. 608 of 1200 teachers contacted, representing all 50 states, responded to the survey; all of these teachers had been recommended to the Center as experienced, innovative users of educational technology. The goal of the survey was to discover the range of these teachers' practices, and the circumstances than have helped or hindered their effective use of new technologies. We found that these teachers have invested considerable time in becoming experienced technology users, use many different technology applications, and are motivated by a belief that computers have changed their teaching styles and helped their students become engaged learners. Inadequate hardware and lack of planning time hamper these teachers' attempts to experiment further with technology applications. These qualities of motivation, support, and access to hardware are crucial to the wider realization of successful technology integration in other classrooms.

AN INTRODUCTION TO THE CENTER FOR TECHNOLOGY IN EDUCATION
videotape; 15 minutes.

This videotape provides an overview of the research agenda of the Center for Technology in Education. A critical framework for understanding the integration of technology into education is presented. Major projects of CTE, including design experiments, multimedia research and development, and alternative assessment research are discussed.